



Oregon

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May 31, 2019

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Subject: DEQ Review “Draft GWET System Effectiveness Evaluation Report”
Arkema Facility, ECSI #398

Dear Mr. Slater:

The Oregon Department of Environmental Quality (DEQ) received the *Draft GWET System Effectiveness Evaluation* (GWET SEE) dated September 2018. The report was prepared by Environmental Resources Management (ERM) for Legacy Site Services LLC (LSS). The GWET SEE was submitted to provide an update on the system, evaluate the extent of capture achieved, and propose actions to improve hydraulic capture.

The GWET system represents the primary method of groundwater contaminant source control at the Arkema site, a high priority project in the Portland Harbor Superfund Site. It is a hydraulic containment system designed with the objective of preventing contaminated groundwater behind the slurry wall from migrating to the river. To achieve this objective, the wells must extract groundwater at rates greater than or equal to the groundwater flux through the alluvial water-bearing zones lying immediately upgradient of the wall. Since precise measurements of groundwater flux and its variability over time are not feasible, performance cannot be evaluated on groundwater extraction rates alone. Instead, a hydraulic analysis that uses monitoring wells clusters, water elevation data and maps, and contouring potentiometric surfaces of the water-bearing zones is the primary line of evidence to demonstrate containment. More specifically, the performance criteria for most barrier wall-groundwater extraction systems including the one constructed at the Arkema site are: 1) inward hydraulic gradients, and 2) an absence of mounding behind the wall. Although, neither of these performance criteria have been achieved at the Arkema site, they will remain the primary lines of evidence in evaluating source control performance.

While not explained in the GWET SEE, the evaluations presented were originally required to be submitted in the form of monthly reports per Section 4.2 of the July 2014 *Revised Final Performance Monitoring Plan-Groundwater Source Control Measure* (Performance Monitoring Plan). After submitting the 2014 plan, operational issues such as treatment system performance limited the volume of groundwater the system was capable of treating and thus the amount of groundwater that could be extracted from the hydraulic containment system. As a result, DEQ agreed to temporarily suspend submittal of the monthly performance reports until the capacity of the treatment system was restored and the extraction wells were pumped at design rates. However, due to the lack of progress in improving system capacity and our incomplete

understanding of seasonal variability in groundwater flows, DEQ requires the return to a monthly reporting format to more closely track overall performance.

Based on DEQ's review of the report it is clear sustainable pumping rates from the extraction wells are substantially less than system design rates, and the existing groundwater extraction system is likely not capable of achieving or sustaining the required inward gradients, even with the proposed actions outlined in this report. Migration of contamination around and possibly under the wall is an ongoing concern given the lack of hydraulic control. Substantial modification of the groundwater management plan is expected to be needed for LSS to demonstrate a functional source control measure is in place prior to the start of the in-water work. DEQ requests LSS schedule a meeting with DEQ within the next month to discuss the issues identified in our review letter.

General Comments

1. The report does not present a capture zone evaluation consistent with the July 2014 *Revised Final Performance Monitoring Plan-Groundwater Source Control Measure*.
2. The adaptive management program, which requires corrective steps to address the lack of inward gradients, has not made substantive progress in the past three years and the root cause of the limited extraction well performance has yet to be identified by LSS.
 - a. As noted in the report, two well redevelopment efforts were completed in 2016 and chemical treatment of extraction well screens with antifouling agents was conducted in March and April 2018 but neither efforts improved operational flow rates.
 - b. The report states a well fouling study will be submitted in January 2019. DEQ has not received this report, and we currently understand that this work is not scheduled until July 2019.
 - c. The March 2017 Wellfield Enhancement Work Plan required the redevelopment and resumption of groundwater extraction from recovery wells 7 and 8. These recovery wells have not been brought back on line, and the report does not indicate why.
 - d. With the exception of attempts to increase well production by well redevelopment and increasing the pump size in a few wells, with limited success, no other adaptive management actions have been proposed or implemented to address the inability of extraction wells to reach target levels since the system was started in 2015 despite not achieving target extraction rates in any of the wells at any time.
3. The lack of sufficient groundwater extraction has resulted in significant mounding of groundwater behind the Groundwater Barrier Wall. This is of concern and needs to be addressed as soon as possible. The increased head has the potential to mobilize NAPL. The lack of capture will cause groundwater contamination to migrate around (which appears to have already occurred) and potentially under the wall.
4. The recommended actions do not appear to be robust enough to achieve the required inward gradients along the entire wall. Redevelopment and the installation of additional wells should occur as soon as possible. The installation of the proposed additional deep wells should not be postponed until after redevelopment of the existing wells, but instead be prioritized.

5. It is unreasonable to believe redevelopment of the existing wells will result in achieving groundwater extraction rates similar or higher than the rates used during the initial pumping test; which in many cases were not sustainable.

Next Steps

1. Status meeting. DEQ requests LSS schedule a status meeting to discuss these comments within the next month.
2. Implement the following previously proposed adaptive management as soon as possible:
 - a. Complete the root cause well fouling study.
 - b. Replacement of pumps in lower producing wells to ensure continuous pumping following redevelopment and pumping test.
 - c. Installation of additional extraction wells to prevent groundwater mounding and capture groundwater migrating around the wall.
3. Re-evaluation of well network given the limitations of the current shallow well construction and available groundwater head during typical groundwater elevation conditions.
4. Initiate monthly status reports consistent with the Performance Monitoring Plan beginning in June 2019 and continuing until submittal and approval of a GWET SEE demonstrating inward gradients at all observation wells clusters.
5. Initiate annual GWET SEEs to be submitted in March of each year.
6. Development of an analytical monitoring program for groundwater contaminants of concern along the Groundwater Barrier Wall starting in July 2019 until inward gradients are demonstrated. Results submitted in monthly status reports upon receipt from laboratory.

Capture Zone Evaluation Comments

While it is evident the GWET system did not achieve inward gradients across the Groundwater Barrier Wall at any time, the GWET SEE did not present a capture zone evaluation consistent with Section 2 of the Performance Monitoring Plan. The monthly status reports and annual GWET SEEs must present a capture zone evaluation consistent with the Performance Monitoring Plan as discussed below.

1. Performance Monitoring Plan Section 2.2.1 Potentiometric Surface and Water Level Difference Maps. Monthly potentiometric surface maps of the shallow, intermediate and deep zones must be presented in the monthly status reports.

Vertical water level difference maps. Monthly vertical water level differences maps must be presented for the well clusters summarized in Table 2-2 of the Monitoring Plan.
2. Performance Monitoring Plan Section 2.2.2 Gradient Control Points. Monthly hydrographs based on Serfes method filtered water level data, of gradient cluster wells superimposed on hydrographs of their corresponding comparison point and river stage data must be presented in the monthly status report.

3. Performance Monitoring Plan Section 2.2.3 Recovery Well Efficiency. This section calls for well redevelopment if well inefficiency is affecting the ability to achieve the target flow rate in a well. Monthly status reports must justify why redevelopment was not implemented if a well did not achieve its target flow rate for the month.
4. Performance Monitoring Plan Section 2.3 Recovery Well Pump Test and Groundwater Model Update. This section calls for a series of pumping tests of individual recovery wells prior to full operation of the GWET system to improve the estimates of aquifer parameters. The data was to be applied to recalibrate the model, along with the specific objectives outlined in Section 2.3. It is unclear if this was done in the current GWET SEE. This is an important step given the issues associated with the initial pumping test and must be presented in the next annual GWET SEE.
5. Performance Monitoring Plan Section 4.2 Performance Monitoring Reporting. This section requires the submittal of monthly reports for the first year of operation. Given the lack of adequate capture at start up and after redevelopment, initiate monthly reports until inward gradients are obtained consistent with the performance requirements identified in the Performance Monitoring Plan.

Specific Comments

1. Section 2.0 Background. Primary component #2 has been changed from what was presented in the Performance Monitoring Plan. The Performance Monitoring Plan states “Hydraulic control (GWET) to prevent groundwater containing unacceptable concentrations of COPCs from moving around, over, or under the contaminated barrier wall”; not to “minimize” as stated in the GWET SEE. Future reports should be consistent with the Performance Monitoring Plan.
2. Section 3.0 GWET System Operating Status. This section does not identify the initial lack of groundwater extraction capacity, which is discussed in Section 5 and is a primary factor in the systems inability to achieve inward gradients.
3. 3.2.4 Groundwater Recovery Pump Settings. It appears pump intakes were lowered in a number of wells to increase the available head. It is not clear if the pump intakes were lowered into the screened zone resulting in aeration of the screen. Aeration of the screened interval may exacerbate fouling and should be avoided if possible.
4. Section 3.2.5 Groundwater Recovery Flow Rates. This section states the anticipated extraction rate was approximately 140 gpm based on the 24 hour pumping tests. However, a maximum recovery rate from the system shortly after startup was 70 gpm. The report attributes changes in the well screens and/or filter pack as the most likely cause of decreased recovery rates. A brief review of the pumping test evaluation indicated two major issues that likely resulted in an overestimation of the initial well extraction capacity.
 - a. Table 1 (attached) indicates stabilized groundwater elevations were not achieved in many of the wells during the pumping tests. In a number of wells water levels were still strongly declining at the end of the pump test, indicating the well was not capable of sustaining the rate it was pumped at. In the worst cases RW11i, RW-24i and RW-26i; groundwater levels dropped to the pump intake resulting in the shutdown of the pump.

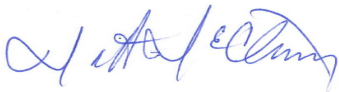
- b. It appears a review of the specific capacity and available head during low water periods was not conducted. The majority of the wells screened in the shallow zone have limited available head due to well construction and pump placement. As a result, there is likely not sufficient groundwater head in the shallow zone to maintain target extraction rate for the majority of the year.
- 5. Section 4.0 Groundwater Elevations. Potentiometric surface maps developed from monthly events were not provided. Future monthly status reports and annual GWET SEE should include these.
- 6. Section 4.0 Groundwater Elevations. This section states *“Shallow groundwater immediately to the north of GWBW, extending under the stormwater detention basin and sand filter is at a similar elevation as the up gradient boundary elevations. This results in groundwater flow direction south and east from Lot 3 and toward the recovery well network, which prevents groundwater from travelling around the north end of the GWBW.”* DEQ does not agree with this conclusion. Groundwater gradients and analytical results indicate groundwater is migrating around the wall at the current extraction rates.
- 7. Section 6.0 Updates to Existing Groundwater Flow Model. As noted in Capture Zone comment 4, the Performance Monitoring Plan required a series of pumping tests of individual recovery wells prior to full operation of the GWET system to improve the estimates of aquifer parameters. The data was to be applied to recalibrate the model, along with the specific objectives outlined in Section 2.3. This is an important step given the issues associated with the initial pumping test and should be completed following redevelopment of the wells and presented in the next annual GWET SEE.
- 8. Section 8 Conclusions.
 - a. Bullet two notes *“Recovery well extraction rates have oscillated in response to groundwater elevation changes...The lower extraction rates resulted from low groundwater levels restricting groundwater extraction.”* It does not appear this conclusion has been taking into account when determining the anticipated flow rates presented in Table 2. DEQ would like clarification on how LSS incorporated this observation in the anticipated flow rates. Please be prepared to discuss this issue in our requested meeting.
 - b. Bullet four states *“Groundwater flow directions indicate that groundwater is not migrating around the ends of the GWBW.”* This statement is not supported by the information provided. Inward gradients at the ends of the GWBW were only briefly observed. Monitoring indicates that for the majority of the time inward gradients were not observed at any of the observation well clusters.
 - c. The modeling presented indicates that under the “optimized” extraction system scenario it is possible to achieve full capture. DEQ has serious concerns with the evaluation as presented for several reasons.
 - i. The evaluation does not present a modeled potentiometric surface showing inward gradients can be achieved, which is the required groundwater source control objective.

- ii. DEQ does not agree it is reasonable to expect redevelopment to restore extraction rates to equal or greater than the initial pumping rates.
- iii. As previously noted by DEQ, we do not agree the pumping tests were conducted appropriately and overestimate the initial sustainable pumping rates for many wells.
- iv. The proposed pumping rates do not take into account the limited available head in shallow wells.
- v. The scenario relies on 80% of the shallow zone extraction from 3 wells. The location of these three wells will not likely be able to achieve the primary objective of the groundwater extraction system which is to achieve inward gradients at all monitoring locations. The plan should be updated to address the limited recovery rates in the other 19 wells.

Unless otherwise stated in the Consent Order, all letters, reports, technical memorandums, and other project submittals are required to be submitted in final form. Where appropriate, documents are required to be stamped in compliance with professional stamping requirements Oregon Revised Statute (ORS) Chapter 672 and applicable Oregon Administrative Rules (OAR).

DEQ requests a meeting to discuss the path forward. EPA and partners have reviewed the GWET SEE, their comments are attached and need to be addressed in the next annual SEE. Please feel free to contact me at 503 229-5538 if you have any questions.

Sincerely,



Matt McClincy, Project Manager
DEQ NWR Cleanup Program

Enclosures (Table 1 & Attachment 1)

cc: Administrative File
 David Lacey, DEQ
 Henning Larsen, DEQ
 Katie Daugherty, DEQ
 Hunter Young, EPA
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